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Lean production approaches benefit space vehicle integration and testing

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WRIGHT-PATTERSON AIR FORCE BASE, Ohio — The Manufacturing Technology (ManTech) Division of the Air Force Research Laboratory's Materials and Manufacturing Directorate and Northrop Grumman researchers have developed a production approach to producing unique space vehicles in a faster, more cost efficient manner.

Applying this production approach to multiple space vehicle builds will save up to 50 percent in costs and 70 percent in cycle time related to mechanical build cycles. These savings are through simplified operations and reduced learning curves, defect occurrences, span times and new capital equipment requirements. Savings should be possible as a result of electronics packaging hardware developed on this program.

The program's need stemmed from the fact that space vehicle Integration and Testing (I&T) is a very costly and time consuming portion of the satellite program, with cycle times ranging from six months to several years in duration. The increasing need to quickly launch new technology has resulted in a focus upon reducing all aspects of space vehicle development and build cycles, including I&T.

ManTech and Northrop Grumman created the Flexible Space Vehicle Production Line Program, FSVPL, that is geared for flexible, variable production volumes for the high performance military and civilian satellite market.

FSVPL focused its efforts in two primary areas. The first area, a design for lean production, focused upon developing designs that would be more easily produced in a volume environment modeled after the "lean production". The method developed by Toyota, has been used throughout the automotive and aviation industries for decades. The second area, standardized electronics packaging, designed, developed, produced and qualified a mechanical package to house electrical components. This package is commonly referred to as the electronic "box," but includes all the mechanical housings inside the box that hold critical electrical components.

The program's technical efforts were then demonstrated in a pilot plant. Full-scale mockups of space vehicles were run through a simulated factory environment to validate program designs and approaches.

Less expensive, higher quality defense satellites, built faster thanks to the manufacturing technology success in the Flexible Space Vehicle Production Line program. (Artist concept courtesy Lockheed Martin)

In the area of design for lean production, the FSVPL team developed a flexible architecture approach to accommodate many missions and orbits with a variety of configuration options. This modular and scaleable architecture approach is focused upon populating panels with equipment such that these panels can be built up in parallel with structural and other subsystem elements. This parallel build approach means

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that several teams of workers can be producing different components of the space vehicle in separate areas concurrently, instead of one team of workers building everything in sequence. The architecture approach is reflected in FSVPL design guidelines developed to translate lessons learned to all new programs.

The crowning achievement of the FSVPL team was the standard electronics packaging design. This design accommodates a highly robust mechanical package allowing for easy installation, access, troubleshooting, and removal and replacement. The design is scaleable and has been fully tested to verify that it meets requirements for the most demanding space missions' thermal and acoustic environments.

The mechanical package has now been baselined on such Air Force programs as the NPOESS (National Polar-orbiting Operational Environmental Satellite System), AEHF (Advanced Extra High Frequency system) and SBIRS Low (Space-Based Infrared System Low).

NPOESS is the nation's next-generation meteorological satellite system. AEHF provides real-time video, battlefield maps and targeting data to the warfighter, and SBIRS Low element is the low-Earth orbiting component of the SBIRS system-of-systems for surveillance capabilities including missile warning, technical intelligence and battle space characterization.

All of these designs and approaches were demonstrated in a pilot plant activity culminating in a demonstration last year. There, Air Force Space and Missile Systems Center, AFRL and NASA customers witnessed the components of FSVPL in a lean production environment, complete with single piece flow, production feeder lines and visual indicators. This two-hour demo showed two different space vehicle models being built from the box level through module integration to model mechanical integration tasks. The benefits of system modularity and parallel production could be clearly seen as components and vehicles moved through factory workstations in a manner similar to an aircraft or automotive plant.

The bottom line is that with FSVPL, more satellites can be built in far less time than ever before, for much less money. @